INDUCTION OF OXIDATIVE STRESS RELATED RESPONSES IN ARABIDOPSIS THALIANA FOLLOWING URANIUM EXPOSURE

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Anthropogenic activities such as uranium mining and milling, metal mining and smelting and the phosphate industry, have caused environmental uranium contamination in many countries. To evaluate the impact of uranium on the environment, it is important to enlarge the scant information available on uranium toxicity effects in plants and unravel by which mechanisms plants respond to uranium stress. The main objective of this research concerns studying uranium toxicity effects on morphological and metabolic level in *Arabidopsis thaliana* plants and investigating the role of oxidative stress as a modulator during uranium stress. Therefore, oxidative stress related responses, together with general developmental alterations, were studied for *Arabidopsis thaliana* plants exposed to uranium concentrations ranging from 0.1 µM to 100 µM.

For *Arabidopsis thaliana* roots, uranium was readily taken up and toxicity effects such as stunted roots, decreased fresh weight and disrupted nutrient profiles were immediately visible after exposure to 100 µM uranium. For the lower uranium concentrations, a transient hormesis effect was visible for root fresh weight. Oxidative stress related responses on the other hand were only visible after exposure to 100 µM uranium. Plasma membranes of the root cells are the first targets of oxidative damage and possibly a fast role for NADPH-oxidases as reactive oxygen species (ROS)-producers, together with fast lipoxygenase-mediated lipid peroxidation, has been suggested. Superoxide dismutase was indicated as an important fast $O_2^{\bullet-}$-scavenging enzyme under uranium stress. The signaling function of ROS is as such allowed for while inhibiting ROS-levels to increase up to levels causing cellular damage. Although, for the detoxification of H_2O_2, catalase and peroxidase were shown to respond by increasing their transcript levels or capacities, the ascorbate/dehydroascorbate redox balance completely shifted towards its oxidized form and this could not be inverted by action of glutathione.

For *Arabidopsis thaliana* leaves, only low uranium concentrations were recorded. Nevertheless, toxicity effects such as a decreased fresh weight and a disturbed nutrient profile were visible for uranium concentrations of 1, 10 and 100 µM. As oxidative stress related responses were also triggered fast and for insignificant uranium concentrations in the leaves, a root-to-shoot signaling system was suggested. In the leaves, a transient response pattern was visible for lipoxygenase-induced lipid peroxidation and responses of the antioxidative defense system based on enzyme capacities, gene expression and glutathione

concentrations. In addition to the fast transient responses, the ascorbate/dehydroascorbate redox balance continuously increased in a concentration and time dependent way, representing either a slow transient response or a stable increase regarding plant acclimation to uranium.
In conclusion, 100 µM uranium is extremely toxic for *Arabidopsis thaliana* plants with a completely inhibited growth, a fully disturbed nutrient profile, wilting and although making an effort to increase the antioxidative defense, suffering from severe oxidative stress with a completely disturbed metabolic balance. While at lower uranium concentrations no oxidative stress related responses are visible in the roots, leaves show an increased defense against uranium stress with an important regulatory role for the ascorbate pool as a stable stress response mechanism.